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LIVES WORTH LIVING:
OLDER SMOKERS' STATED PREFERENCES
FOR LONGEVITY

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Lives Worth Living:
Older Smokers' Stated Preferences for Longevity

Introduction

Cigarette consumption is different from the consumption of most other market goods both because it is addictive and because of its well-known health risks. The debate leading to the state tobacco settlements in 1997 and 1998 has stimulated renewed interest in reducing tobacco use. This interest in smoking-reduction initiatives has highlighted the need for a better understanding of smokers' motives, perceptions, and preferences.

Despite the effectiveness of information programs in raising public awareness of smoking risks, many people continue to smoke, even late in life. The effectiveness of such messages in changing behavior depends on current and potential smokers' willingness to exchange improved health for the direct benefits of tobacco consumption. The persistence of smoking may indicate that smokers are less risk averse and value good health less than the general population. Alternatively, smokers may value the benefits of smoking more than the general population. Previous research has modeled the smoking decision using market data (Jones 1989, Blaylock, and Blisard 1992). However, knowledge of smoking risks is so pervasive in the U.S. that market data necessarily confound smokers' attitudes toward smoking-related health risks and preferences for smoking itself. Disentangling health and smoking preferences could improve our understanding of smoking decisions and help inform public-health programs to reduce smoking-related morbidity and mortality.

Stated-preference (SP) or conjoint surveys avoid such collinearity by constructing hypothetical markets. This approach gives researchers experimental control over product attributes, market institutions, and consumer information. SP methods evolved as market-research tools for evaluating consumer behavior and predicting sales of new products (Cattin and Wittink, 1982; Wittink and Cattin, 1989). SP recently has been applied in environmental and health economics as a more flexible alternative to contingent-valuation methods when market data are unavailable or uninformative. Viscusi, Magat, and, Huber (1991) and Krupnick and Cropper (1992) (using the Viscusi data) used SP analysis to elicit values for reducing chronic health risks. Other SP studies have elicited preferences for other health and health-care attributes, including Ryan, McIntosh, and Shackley (1998), Chkroborty, Gaeth, and Cunningham (1993), Ryan and Hughes (1997), Bryan et. al. (1997), Van der Pol and Cairns (1998), and Propper (1995).

Previous studies generally have focused younger smokers, where smoking initiation rates are highest. This study focuses instead on current smokers aged 50-64, who often are beginning to face the tangible health consequences of smoking. Subjects were offered three choices: two alternatives with hypothetical cigarette filters that reduce the health risks of smoking and one alternative with a constant, unimproved health profile. The utility obtained under different health states is derived from the revealed trade-offs among the alternatives. The experimental design allows us to explicitly model smokers' preferences for quality of life (QoL) and longevity and to develop approximations to willingness to pay for combinations of the attributes.

The focus of this paper is not on smoking behavior. Rather, we are interested in whether health information affects smokers' value of increases in longevity. If it does, then a composite message that emphasizes longevity and quality of life may be more effective with long-term smokers. Our results are reassuring about the ability of older smokers to express well-conditioned health preferences. Stated preferences are appropriately sensitive to the nature and scope of alternative health outcomes and vary predictably with personal characteristics, including perceived risk, age, and income. Significantly, smokers' preferences indicate positive willingness to pay for improved longevity only if their quality of life is good. The remainder of the paper outlines the conceptual framework, design of the experiment, and empirical results that are the basis of these conclusions.

Conceptual Framework

Most people understand that smoking significantly increases the risk of respiratory and coronary diseases and decreases life expectancy. Nonetheless, people continue to smoke.

This behavior has been a challenge to conventional economic models of consumer behavior that assume rationality and, when describing consumption choices over time, rely on some type of forward-looking behavior. Becker and Murphy's (1988) rational addiction model has been the dominant framework used to explain these seemingly contradictory observations about smokers' beliefs and their behavior.

The rational-addiction framework relies on what the authors describe as the adjacent complementarity of cigarette consumption over time. This property of consumer preferences implies that both current consumption and the stock of past consumption of cigarettes contribute to well-being. Moreover, it requires that the marginal utility of cigarette consumption increase as the stock of past consumption increases. This addictive characteristic of preferences explains how increases in current consumption of cigarettes can lead to increases in future consumption.[1]

The net effect of addiction for rational choice is not clear in their model. Many possible factors can contribute to the response of quantity of cigarettes demanded to price. In particular, the inter-temporal optimization framework implies that the full price of cigarettes is higher than the current price. As a result, smokers' rate of time preference and rate of depreciation in the stocks of past consumption, along with the curvature properties of preferences, contribute to the realized time profile of consumption.

While the rational-addition model acknowledges the health effects of smoking, it does not explicitly include links between the stock of consumption and risks of premature death or degradation in what often is termed health capital (Grossman 1992). Generalizing the model to account for such links is not especially informative. The generalization simply identifies some factors that might mute the effects of adjacent complementarity.

A simpler approach will serve to frame our evaluation of health messages about smoking risks. Our proposed alternative is based on a simplification Becker (1992) used to highlight the key features of rational addiction. Using a modified Stone-Geary utility function and assuming cigarette consumption is separable from other goods, he illustrates how the strength of addiction

[1] For a recent evaluation of the rational addiction model, see Ferguson (2000).

affects the steady state responses in consumption. A simple extension to that logic allows us to frame our hypotheses.

Assume that the cigarette–consumption utility is composed of two parts—one describing smokers' addiction to smoking and a separable effect describing smokers' disutility from diminished health.

$$U_t = V(C_t - \alpha \cdot \delta \cdot S_t) + \mu[H(S_t)] \tag{1}$$

where: $V(C_t - \alpha\delta S_t)$ is the addiction component

C_t is cigarette consumption in period t

α is a constant to incorporate adjacent complementarity ($\alpha > 0$)

δ is depreciation rate for past consumption $(\dot{S}_t = C_t - \delta S_t)$

S_t is stock of past consumption

$\mu(H(S_t))$ is the disutility of diminished health

μ is the marginal utility of health

$H(S_t)$ is the health stock, $\partial H / \partial S_t < 0$

We add to this simple model one further assumption—smokers recognize that the stock of smoking influences their likelihood of premature mortality. Thus, their survival probability $\pi(S_t)$ is also a function of the stock of cigarettes consumed.

If smokers maximize expected utility subject to a simple budget constraint (with no bequest motives), we can describe how their steady-state consumption of cigarettes $(\dot{S} = 0)$ responds to a change in price, P_c. The necessary condition (dropping time subscripts) is given in equation (2).

$$\pi'\cdot\left\{\frac{1}{\delta}V\left[C(1-\alpha)\right]\right\} + \frac{1}{\delta}\mu\left[H\left(\frac{1}{\delta}C\right)\right] + \pi\cdot\left[V'\cdot(1-\alpha)+\frac{1}{\delta}\mu'H'\right] = \lambda P_C \quad \textbf{(2)}$$

where (1-α) is the effect of addiction on consumption and π' is the effect of continued smoking on premature mortality. Thus, the expected marginal gains for current smoking are discounted by the perceived effects on health ($H' < 0$), as well as the prospect of losing future consumption ($\pi' < 0$). Both serve to reduce the marginal utility of current cigarette consumption.

If we assume the marginal utility of wealth (λ) is approximately constant, then equation (2) can be used to derive the responsiveness of steady-state demand to price in (3):

$$\frac{dC}{dP_C} \approx \frac{\lambda}{\pi\left[V''\cdot(1-\alpha)^2+\left(\frac{1}{\delta}\right)^2\cdot\mu''\cdot(H)^2+\left(\frac{1}{\delta}\right)^2\cdot\mu'\cdot H''\right]+2\pi'\left[\left(\frac{1}{\delta}\right)\cdot V'\cdot(1-\alpha)+\left(\frac{1}{\delta}\right)^2\mu'H'\right]+\pi''\left[\left(\frac{1}{\delta}\right)^2\cdot V+\left(\frac{1}{\delta}\right)^2\mu\right]} \quad \textbf{(3)}$$

There are three composite terms in the denominator of equation (3). The first (without the effect of H") would be negative, and in the absence of perceived smoking risks would assure a downward-sloping steady-state demand. The size of the price response depends on the strength of the habit ($\alpha < 0$ and $(1-\alpha)^2$ scale diminishing marginal utility).

Because smoking also affects health capital and mortality probability, perceptions about these risks will influence how smokers will respond to price increases. However, studies of the relationship between smoking and risk perceptions have yielded contradictory findings. For example, Viscusi (1990) found that smokers actually overestimate the risk of lung cancer due to smoking. However, his results have been controversial. For example, Schoenbaun (1997) found that heavy smokers *understate* the risks they face. Furthermore, Smith et al. (2000) found that smokers update their longevity expectations differently than non-smokers in response to health shocks. While smokers initially may understate their mortality risks, they are more willing to recognize the risks of smoking after a serious smoking-related health shock. Using the same panel data, Lahiri and Song (2000) recently investigated the effect of health risks on cessation behavior in older smokers. They find a significant relationship between perceived risk and the probability of getting a smoking-related disease.

Our model suggests that several factors should influence how smokers respond to information messages about the health effects of smoking. Among these is the focus of the message. We distinguish the perceived effect of smoking on mortality risks (i.e., the magnitude of π' and the sign and magnitude of π'') and the impact of smoking on health capital. Even if smokers recognize the links between S and π, they may not fully appreciate the steady-state effects on health capital.

These perceptions are the target of our conjoint analysis. Both addiction and adverse health effects are at work in (3), but in opposite directions. Thus the net effect is an empirical question. Unfortunately, these effects are confounded in market data and cannot be separately identified. Our experiment disentangles these two effects and allows us to estimate smokers' health preferences. The preference elicitation task focuses smokers' attention on H'' and H', measured by the quality of life associated with sustained smoking. Thus, even if they generally accept that $\pi' < 0$, a failure to recognize health effects can have a substantial influence on price responsiveness even after accounting for addictive behavior.

Thus, despite the past evidence that excise taxes may be more effective in deterring smoking than information programs, it may be that these findings say more about the focus of those programs than the effectiveness of smoking information programs. Specifically, our study seeks answers to two questions related to the relative strength of addictive and adverse-health effects:

- First, can older smokers, who have realized some level of addiction to cigarettes, discriminate appropriately among alternative health outcomes in an experimental setting?
- If so, do their stated preferences behave as expected? That is, do smokers systematically value worse health states less than better ones, after controlling for addiction utility?

If the answers affirm these links, then a re-designed information program may offer an effective supplement to pricing policies designed to reduce smoking.

Data

In July 1999, we collected a quota sample of 248 older smokers in Raleigh, NC. The sample characteristics were designed to approximately match those of the National Health and Retirement Survey (HRS) (Juster and Suzman 1995).[2] Thus, the age of subjects varied between 50 and 64. A survey research firm recruited 282 smokers to a central location to take a computerized survey. Of the 282 recruited, 248 completed the survey. Four subjects' data were discarded because of survey-administration errors.

The computerized survey first collected background information, including socio-demographic, personal health, and parental health information. The survey inquired about the subject's smoking attitudes, habits, and perceived likelihood of living to ages 75 and to 85 using the same format employed in the HRS questionnaire.

The survey also led subjects through a series of stated-preference (SP) evaluation tasks. The SP task required subjects to evaluate paired descriptions of hypothetical cigarette filters that reduce the health effects from smoking without reducing the benefits of smoking. The description asked subjects to suppose that a company that had no affiliation to the tobacco industry developed the filter.[3] The description suggested that the filters could be easily attached to the cigarette and were intended to be discarded with the cigarette after it was smoked.

Subjects viewed a series of nine SP choice sets with three alternatives from which they could choose one. The first two alternatives profiled the attributes of the health state a respondent would experience with these filters. These profiles told subjects the increased life expectancy that they could expect if they used the filter with their cigarettes, the QoL during that increased life, and the price of the filter. The final alternative allowed subjects to choose not to

[2] The Health and Retirement Study (HRS) is a large national panel dataset conducted in waves undertaken every two years starting in 1992. At the outset of the process, the primary respondent in each household was selected to be between 51 and 61 years of age.

[3] In focus groups, smokers were reluctant to accept claims of reduced health effects from companies unless they were explicitly stated to be independent of tobacco companies.

purchase a filter and thus receive no increase in life expectancy. The QoL for this alternative was set to the same-gender parent's QoL.[4]

Table 1
Levels of the Quality-of-Life Attribute

Level	Description
DRIVE	"You are able to drive. You are able to walk a few blocks."
LEAVE	"You are able to leave your home with assistance. You have difficulty getting in and out of chairs."
WALKER	"You are rarely able to leave your home. You walk with the assistance of a walker. You need help dressing and bathing."
BED	"You are unable to leave your bed. You can not eat, dress, bathe or use the toilet without help."

The life extensions offered to subjects varied by gender. Female respondents saw filter alternatives that provided life extensions of 12, 26, or 45 months. Male subjects saw filter alternatives that provided life extensions of 10, 20, or 36 months.

These life extensions are consistent with the increased life expectancies that accrue to female and male smokers who quit. The life extensions were described as taking place at the expected end of life: 77 for female smokers and 73 for male smokers.

The QoL levels are adapted from the functional states used in the Quality of Well Being (QWB) scale (Kaplan et. al. 1993)[5]. Table 1 shows the four quality-of-life levels. The filter prices were set to \$2.00, \$6.00, or \$10.00 in addition to the stated \$3.00 price for a package of cigarettes. Figure 1 shows a sample choice set for a female subject.

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[4] Subjects indicated their same-gender parent's QoL just before beginning the SP choice section. If the parent was living, subjects selected the level best describing the parent's QoL over the previous three months. If the parent was deceased, subjects selected the level best describing the parent's QoL during the last three months of his or her life.

[5] The QWB scale describes functional state index in four dimensions: mobility, physical activity, social activity, and symptom-problem complex. We adapted this index to a single dimension to ease cognitive burden on subjects. Pretests showed that these are meaningful levels to subjects.

Figure 1
Example of Stated-Preference Screen

Category	Filter A	Filter B	No Filter
Life extension	You will have 26 months added to your life at age 77.	You will have 45 months added to your life at age 77.	You will have no additional time added to your life at age 77.
Quality of life during extension	• You are rarely able to leave your home. • You walk with the assistance of a walker. • You need help dressing and bathing.	• You are unable to leave your bed. • You cannot eat, dress, bathe, or use the toilet without help.	• You are able to leave your home with assistance. • You have trouble getting in and out of chairs.
Price of filters	$10.00 per pack of 20 filters in addition to the $3.00 per pack of 20 cigarettes.	$2.00 per pack of 20 filters in addition to the $3.00 per pack of 20 cigarettes.	No cost in addition to the $3.00 per pack of 20 cigarettes.
Which filter do you prefer?	❍ Filter A	❍ Filter B	❍ No filter

The experimental design for the filter alternatives sought to maximize the information obtained from the observed choices, minimize the sequence effects, and control for cognitive effects. To maximize information obtained from the SP survey, we generated a statistically efficient experimental design using an algorithm developed by Zwerina, Huber, and Kuhfeld (1996). The design incorporates interactions between the QoL and life-extension attributes.[6] These interactions are important because they allow subjects' choices to reveal whether the value of a given increase in longevity depends on the quality of life experienced during that extension. This interdependence is implicit in the health-capital effect hypothesized to influence smokers' steady-state response to an increase in the price of cigarettes.

To control for sequence effects, we employed a block design and varied the order of SP questions. We constructed three blocks of six pairs of alternatives from the set of 36 unique alternatives derived from the attributes and levels. Each subject viewed one of the three blocks.

[6] Domination in this case requires that each attribute of one alternative be clearly better than the corresponding attribute in the second alternative. The design generated by the computer does not allow dominated pairs. However, as described below, one dominated pair is included in the survey to test for the subject attentiveness.

The experimental design orders the questions in each of the three blocks in five different sequences. Therefore, subjects were randomly assigned to one of the three blocks and to one of the five sequences within the assigned block for a total of fifteen possible branches. Three additional SP questions follow the six unique questions described above to control for cognitive effects. The seventh question offers a pair of filters where one filter dominated the other to test for attentiveness. The final two questions repeat the first two questions to test individual attentiveness and sample variation between the beginning and end of the sequence.[7]

Following each of the choice sets in which subjects chose a filter, the survey requested the subjects' demand for cigarettes using the filter. The question emphasized the total cost of smoking a pack of cigarettes with the chosen filter by providing the sum of the price of the chosen filter and the price of cigarettes. If subjects chose the no-filter option, they were not asked a demand question, but immediately viewed a new choice set.

Table 2 provides sample statistics for the 243 smokers with usable data. The average age of smokers was 55 years, with nearly 40 percent male and more than 85 percent white. Sixty percent completed some or all college, while 87 percent own their own homes. The majority of the sample has been smoking 16 years or more. Most smoke between one and two packs of 20 cigarettes a day.

Model Specification

We employ a simultaneous model to jointly estimate filter choice and demand. The model is simultaneous because the structure of the survey implies a simultaneous decision. Subjects may consider the demand for cigarettes and filters when selecting the filter, and the demand for cigarettes and filters is dependent on the alternative chosen.

[7] Johnson, Mathews, and Bingham (2000) found highly consistent preferences in these data by testing for monotonicity, transitivity, and stability. For example, only two subjects failed to choose the correct alternative in the dominated pair.

Table 2
Sample Statistics

N = 243	
Average Age	55.1 years
Male	40.0 percent
Race: White	85.2 percent
Black	13.2
Highest Education Level attended or completed	
High school	21.0 percent
College	60.1 percent
Post-graduate	18.9 percent
Average yearly family income	$ 68,000
Married	61.0 percent
Widowed	5.0 percent
Employment status	
Retired	23.1 percent
Worked during previous year	83.1 percent
Number of years smoked (percent of subjects)	
>35 years	33.1
26-35	44.2
16-25	18.6
6-15	3.7
<5	<1.0
Usual smoking pattern)percent of subjects)	
1-9 cigarettes/day	17.7
10-19	25.1
20	20.6
21-39	31.3
40+	4.9
Average number of alcoholic drinks per day	0.41
Same gender parent died of cancer	12 percent
Likely length of life (average ranking on a 1-10 scale where 10 is absolutely certain)	
Live to 75 (before SP survey)	7.3

Filter Choice

We assume subjects maximize utility as a function of health capital, cigarette consumption, and other goods. Differences in the effects of addiction are assumed to be controlled through our selection of a sample of older smokers. Nearly all smokers initiate their consumption between 18 and 24. Thus, by focusing on older smokers, we have partially controlled for long-term addiction, which is reflected in the model's parameters. Applying this theoretical structure to the decisions that subjects made in the SP survey, we assume that subjects chose an alternative if the utility derived from that alternative was greater than the utility received from the other choices, after considering both the attributes of the choices and associated costs.

Individual indirect utility for each alternative is approximated using a linear function of the filter attributes and net income:

$$U_{if} = X_f \beta_f + \delta_N N_{if} \tag{4}$$

where f denotes filter alternative and i denotes individual respondent. X_f is a filter-specific, QoL-longevity interaction, and β_f is the associated parameter. Net income N_{if} is yearly income less expenditures on cigarettes and filters, if purchased. Net income is represented as $Y_i - \left(p_q + p_f\right) \cdot q_{if}$, where the prices of cigarettes and filters are p_q and p_f, respectively. Cigarette consumption is q_{if} and δ_N is the marginal utility of income. This specification is consistent with well-behaved preferences, provided we assume income and prices are scaled by a composite price index normalized to unity. Cigarette consumption is endogenous and will itself be a function of cigarette prices, the price of filters, and the attributes of the life extension conveyed through the filter choice.[8]

The utility of the opt-out alternative allows the QoL variables to vary by individual and adds additional individual-characteristic covariates.

$$U_{io} = X_{io} \beta_o + \delta_N N_{io} + Z_o \gamma \tag{5}$$

[8] Chiang and Lee's (1992) discrete/continuous estimator offers an alternative approach to this problem. This approach models choice decisions as a three-stage consumer purchase. First the consumer decides whether to purchase a commodity, then selects a brand, then decides how many units of the brand to purchase. In our context, they equate the corner solution of choosing a filter alternative or opt-out condition to the conditional demand. In what follows we adopt a simpler strategy for two reasons. First, we are not attempting to estimate how the demand for cigarettes would respond to the health information. Rather, we are interested in whether the health information affects the value of increases in longevity. Second, the Chiang and Lee approach produced results for our data that were difficult to interpret because it doesn't explicitly account for the competing, respondent-specific attributes of the status-quo alternative in the SP experimental design. The approach reported here obtains explicit estimates of status-quo utility that are important for evaluating welfare changes.

Because the opt-out longevity extension is zero, X_{io} is not interacted with the extension, but is just the QoL category. In addition, in this case $N_{io} = Y_i - p_q \cdot q_{io}$, where p_q is the price of a pack of cigarettes ($3) and q_{io} is current cigarette consumption.

For estimation we assume $V_{if}^{\tau} = U_{if} + \varepsilon_{if}^{\tau}$ and $V_{io}^{\tau} = U_{io} + \varepsilon_{io}^{\tau}$. Assuming that ε^{τ}, is distributed with an independent Type I Extreme Value distribution with mean zero, the probability that subject i selects alternative j in choice set t (i.e., $s_{i_t} = j_t$) is

$$\Pr(s_{i_t} = j\tau) = \frac{\exp[U_{ij_t}]}{\sum_{k=0}^{2} \exp[U_{ik_t}]} \qquad \textbf{(6)}$$

where j = 0, 1, 2.

Cigarette Consumption

The smoker's demand for cigarettes is a function of the price of cigarettes and filters, the quality of life associated with the health effects of smoking as mitigated by the hypothetical filters, and income. Applying Roy's identity to equation (4), ignoring unobserved heterogeneity from the error terms in (4) and (5), yields the demand function q_{if} (P_g, $P_{f,}$ γ).

$$q_j = X_j\eta + Z_i^d\theta + (\lambda^M + Z_i^M\lambda^Z)(p_c + p_{fj}) + \varepsilon_j \qquad \textbf{(7)}$$

where q_j is the number of cigarettes demanded, and Z_i^d is a vector of personal characteristics. η, θ and λ are parameter vectors and ε is the random disturbance. We allow the shape of the demand curve to be a function of personal characteristics (Z_i^M). The two models are jointly estimated to reflect the effects of filter choice on demand but do not at this point allow for error correlation or cross-equation restrictions.[9]

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[9] We allow for non-linear expressions for (4) and (5) and cross equation restrictions between the choice and demand functions. It does not consistently incorporate the unobserved heterogeneity across respondents. Chiang and Lee's framework does, but requires restricting the role of the health effects to be consistent with cross-product repackaging.

To answer the demand question in the survey, subjects chose a range of cigarettes that included the number of cigarettes they would smoke when purchasing filters. If no filter was purchased, we assumed that the subject would continue smoking in their current range. In other words, q_j is not observed. Therefore, we estimate the probability that the subject will choose a cigarette quantity within the selected range. The probability that the subject will chose a range, h, with upper bound B_L^h and lower bound B_U^h is:

$$\begin{aligned}
\Pr\left(B_L^k < q_j \le B_U^k\right) &= \Pr\left(B_L < X_j\eta + Z_i^d\theta + (\lambda^M + Z_i^M\lambda^Z)\left(p_q + p_f\right) \le B_U\right) \\
&= \Pr\begin{pmatrix} B_L - X_j\eta - Z_i^d\theta - (\lambda^M + Z_i^M\lambda^Z)\left(p_q + p_f\right) < \varepsilon_j \\ \le B_U - X_j\eta - Z_i^d\theta - (\lambda^M + Z_i^M\lambda^Z)\left(p_q + p_f\right) \end{pmatrix} \\
&= \Phi\left[\frac{X_{it}\alpha + Z_i^q\eta + (\lambda^p + Z_i^p\lambda^z)\left(p_q + p_{it}\right) - B_U^h}{s}\right] \\
&\quad - \Phi\left[\frac{X_{it}\alpha + Z_i^q\eta + (\lambda^p + Z_i^p\lambda^z)\left(p_q + p_{it}\right) - B_L^h}{s}\right]
\end{aligned} \quad \textbf{(8)}$$

where s is the estimated standard deviation of the distribution. The upper bounds B_L^k and lower bounds B_U^k come from responses to two types of questions. The bounds for the opt-out (no-filter) alternatives come from the subject's selection of a category that describes their usual smoking pattern.[10] The bounds for the chosen filter are obtained from the demand question that followed each SP choice set.[11]

This would limit the relevance of the resulting model as a test for the overall behavior implicit in our general model. As a result, we have not exploited the prospects for cross-equation restrictions and simply specify an approximate cigarette demand as in equation (7).

[10] Subjects choose from the following categories to indicate their usual consumption of cigarettes: 1-9 cigarettes/day, 10-19 cigarettes/day, 20 cigarettes/day (1 pack), 21-39 cigarettes/day, 40 or more cigarettes/day.

[11] After the subject chooses a filter, they indicate one of eight categories that represent how much they would smoke given that choice: 1-5 cigarettes/day, 6-10 cigarettes/day 11-15 cigarettes/day, 16-19 cigarettes/day, 20 cigarettes/day (1/pack), 21-30 cigarettes/day, 31-39 cigarettes/day, 40 or more cigarettes/day.

Joint Likelihood Function

Let d^i_{ot} and d^i_{jt} be one if subject i chooses the opt-out alternative or filter j in repetition t, respectively, and d^i_{ht} be one if subject i chooses demand range h in repetition t. The likelihood of choosing both simultaneously is

$$L_i = \prod_t \left\{ \begin{array}{l} \left(\dfrac{\exp\left(X_{iot}\beta_o + \delta_N N_{iot} + Z_i^o\gamma\right)}{\exp\left(X_{iot}\beta_o + \delta_N N_{iot} + Z_i^o\gamma\right) + \sum\limits_{k=1}^{2}\exp\left(X_{ikt}\beta_f + \delta_N N_{ikt}\right)} \right)^{d^i_{ot}} \\ \cdot \prod\limits_j \left(\dfrac{\exp\left(X_{ijt}\beta + \delta_N N_{ijt}\right)}{\exp\left(X_{iot}\beta_o + \delta_N N_{iot} + Z_i^o\gamma\right) + \sum\limits_{k=1}^{2}\exp\left(X_{ikt}\beta_f + \delta_N N_{ikt}\right)} \right)^{d^i_{jt}} \\ \cdot \prod\limits_h \left(\Phi\left[\dfrac{X_{it}\alpha + Z_i^q\eta + (\lambda^p + Z_i^p\lambda^z)\left(p_q + p_{it}\right) - B_U^h}{s} \right] - \Phi\left[\dfrac{X_{it}\alpha + Z_i^q\eta + (\lambda^p + Z_i^p\lambda^z)\left(p_q + p_{it}\right) - B_L^h}{s} \right] \right)^{d^i_{ht}} \end{array} \right\} \quad \textbf{(9)}$$

where X_{it} is the opt-out or filter attributes for the selected alternative in the choice stage. We obtained full-information maximum likelihood estimates of the parameters in equation (9).

Model Results

Table 3 reports results from a model that includes explanatory personal characteristics, uses the log of number of cigarettes in the demand stage and includes covariates with the opt-out alternative. Logging quantity prevents negative demand predictions. In the demand model, individual-specific covariates are important explanatory variables.[14] QoL-longevity interactions do not appear to play a large role in describing how subjects choose the quantity of cigarettes

[12] When variables are effects coded, the coefficient for the omitted category is the negative sum of the coefficients of the other categories. T-tests thus are relative to the mean effect, which is equal to zero by construction. In the choice stage of the parsimonious model, the marginal utility of the extension-bedridden attribute is -0.62.

[13] We report only models based on log transforms of net income. Box-Cox analysis indicates log is the appropriate functional form.

[14] All the variables are dummy variables except for the number of years smoked, age, number of alcoholic drinks, income, and live-to-75 rating.

conditional on the filter choice. The top two QoL-longevity levels are not significantly different from the mean effect.

Higher-income subjects demand fewer cigarettes while college graduates demand more cigarettes. Older, white males also demand more cigarettes. The addictive nature of smoking is reinforced; subjects who have smoked longer demand more cigarettes, confirming the general expectations of the rational-addiction framework. Subjects with higher longevity expectations under the baseline conditions demand fewer cigarettes. Alcohol and cigarettes are found, consistent with the literature, to be complementary habits. Somewhat surprisingly, subjects whose same-gender parent died of cancer demand more cigarettes.

After the first time subjects selected a filter and responded to the demand question, they were asked to indicate for what percent of these cigarettes they would use a filter. Subjects who indicated that they would use the chosen filter for all cigarettes demand fewer cigarettes compared with subjects who do not plan to use the chosen filter for all cigarettes. In a complete analysis, we would incorporate this choice into a model consistently describing the price and demand. This finding indicates that there may well be a payoff to exploiting this endogeneity because the response here is consistent with the differential effect of the price of the filters for the two groups.

In the choice stage, filter attributes are very important choice determinants. They are significantly different from the mean effect and from each other, and are in an order consistent with our a priori expectations.[15] The mean effect is between "must use a walker" and "able to leave home with assistance." Net income is positive and a significant determinant of filter choice. As the price of the filter decreases (thus raising net income), the more likely the alternative will be chosen.

[15] The implicit coefficient on choice of the omitted category (“Extension-Bedridden”) is -0.65.

Table 3
Full Model (Demand Stage)

Explanatory Variables	Estimates
Demand Stage	
Constant	1.75***
Opt-out chosen	0.41***
Life Extension * Must use a Walker#	-0.04*
Life Extension * Leave Home#	0.003
Life Extension * Able to Drive#	0.005
Income (in $1000s)	-0.002***
Number of years smoked	0.02***
Live to 75 rating	-0.02**
Would use filter chosen for 100% of cigarettes	-0.17***
Same gender parent died from cancer	0.12***
Male	0.17***
White	0.47***
Number of alcoholic drinks per day	0.11***
College graduate	0.07***
Demand Stage: Marginal Utility of Money Function	
Constant	0.0073
Income ($1000s)	0.0002***
Age	-0.001***
Model Fit	
Maddalla's pseudo R-square	0.36
Percent correctly predicted	36.8

*** Significant at 1%, ** Significant at 5%, * Significant at 10%
# Effects coded

Table 3, continued (Choice Stage)

Explanatory Variables	Estimates
Choice Stage	
Extension * Must use a walker#	-0.25***
Extension * Leave home#	0.06**
Extension * Able to drive#	0.84***
Net income: ln[Y - Q* (P+$3)]	9.02***
Opt-out covariates (choice stage)	
Constant	0.73
Must use a Walker#	-0.50***
Able to Leave Home#	0.05
Able to Drive#	1.22***
Number of years smoked	0.03***
Age	-0.04***
Probit standard deviation	0.56***
Model Fit	
Maddalla's pseudo R-square	0.43
Percent correctly predicted	55.8

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

Effects coded

The QoL variables interacted with the opt-out alternative also are consistently ordered.[17] "Bedridden," "must use a walker," and "able to drive" are significantly different for the mean effect ("able to leave home with assistance"). Subjects who have smoked longer are more likely to choose the opt-out alternative. However, older smokers are less likely to choose the opt-out alternative.

Expected longevity is calculated from life tables for a male or female smoker in this age cohort. Expected QoL is the sample same-gender parent's QoL during the last three months of life (if not living) or current QoL if living. QoL is about evenly distributed between living and not living same-gender parents, and an indicator variable for same-gender parent living was not significant. We also hypothesized that subjects' current health and expected health may affect baseline utility[18]. In models with these variables included in the demand and/or opt-out covariates, these variables are significant.

Calculating Willingness to Pay

Estimating the parameters of the utility function enables us to develop approximate value estimates of longevity at various QoL levels relative to the status quo. Let X_{io} indicate the status-quo vector of attribute levels, which is the subject's same-gender parent's QoL and gender-specific longevity. The unit price of X_{io} is p_q, which we take to be \$3, the given price of a pack of cigarettes. X_{if} indicates a changed vector of attribute levels corresponding to a given combination of QoL and longevity attributes. WTP for a given improvement in longevity from X_o to X_f is the reduction in net income that equates utility with and without the improvement. From Eq. (4),

$$U_{if}\left(X_f, N_{if}; \beta_f, \delta_N\right) = U_{io}\left(X_o, N_{io} - WTP_{if}; \beta_o, \delta_N\right)$$

$$X_f\beta_f + \delta_N \ln(N_{if}) = X_o\beta_o + \delta_N \ln(N_{io} - WTP_{if}) \qquad \textbf{(10)}$$

$$WTP_{if} = N_{io} - \exp\left[\frac{X_f\beta_f + \delta_N \ln(N_{if}) - X_o\beta_o}{\delta_N}\right]$$

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16 The implicit coefficient on choice of the omitted category ("Extension-Bedridden") is -0.65.

17 The implicit coefficient on choosing the opt-out alternative when QoL is "bedridden" is -0.77.

18 Subjects provided information on their current health by reporting diseases that a doctor has diagnosed them with. Subjects provided information on their expected health by indicating which disease they feel will likely be their cause of death.

Our analysis recovers parameters for a complete utility index. As a result, WTP can be constructed for any utility difference. Tables 4 and 5 present mean WTP estimates and Krinsky-Robb 90% confidence intervals.[19] WTP is calculated relative to each individual's baseline utility obtained from the opt-out alternative. Thus WTP will be positive if the health outcome is better than baseline and negative if worse than baseline. In Tables 4 and 5, annual WTP is converted to the future value of one- and three-year life extensions as follows:

- First, the stream of annual payments over the expected remaining years of life is discounted to present value using 3% and 7% discount rates for each respondent.
- Second, the resulting present values are compounded at each discount rate to the corresponding future value at expected age of death to obtain the implicit value of one- and three-year life extensions.

Regardless of discount rate, mean WTP is not significantly different from zero for a 3-year life extension with "Able to leave home" quality of life, implying this outcome is equivalent to subjects' average perceived baseline utility with no life extension and same-gender parent's quality of life. Shorter life extensions and lower QoL levels yield negative WTP and longer life extensions and higher QoL levels yield positive WTP.

Note that WTP is more sensitive to QoL levels than to longevity levels. WTP estimates for "Able to drive" and "Able to leave home with assistance" are significantly different from each other at both life-extension levels, while "Able to leave home with assistance" is significantly different from "Unable to leave the bed without assistance." At a given QoL, life extensions are significantly different from each other only at the best QoL level.

[19] Our qualitative results are similar to those reported here for a wide range of model specifications.

Table 4
Mean Future Value for Life Extensions ($1000s)
3% Discount Rate
(90% confidence intervals in parentheses)

Restriction	Life Extension 1 year	 3 years
Unable to leave the bed without assistance	-199 (-406/-131)	-436 (-893/-288)
Must use a walker	-119 (-224/-75)	-219 (-452/-135)
Able to leave the home with assistance	-53 (-87/-22)	-26 (-64/45)
Able to drive and leave the home independently	118 (60/426)	543 (309/1875)

Table 5
Mean Future Value for Life Extensions ($1000s)
7% Discount Rate
(90% confidence intervals in parentheses)

Restriction	Life Extension 1 year	 3 years
Unable to leave the bed without assistance	-326 (-669/-214)	-709 (-1453/-468)
Must use a walker	-197 (-375/-124)	-357 (-741/-220)
Able to leave the home with assistance	-91 (-149/-42)	-47 (-110/64)
Able to drive and leave the home independently	186 (93/671)	872 (496/2999)

Our results help to explain some discrepancies in previous estimates of value per life year. One set of estimates is based on amortizing an assumed value of a statistical life over expected remaining life-years for an average person at a given discount rate (Moore and Viscusi, 1988; Miller, Calhoun, and Arthur, 1990; Tolley, Kenkel, and Fabian, 1994; Cutler and Richardson, 1999). Tolley, et al. (1994) report a range of $70,000 to $175,000 per-life year from this literature. These estimates are for average, amortized values of a statistical life, not for the marginal value of a one-year life extension. In contrast, Johannesson and Johansson (1996, 1997) report estimates for a one-year life extension from a contingent valuation survey in Sweden. They report a mean present value of about $1,500 for a one-year life extension at age 75. Although the survey does not specifically describe the health state during that additional year, the authors speculate that the low WTP value reflects respondents' assumption of low QoL. They also note these estimates are consistent with a previous study where respondents judged saving thirty-five 70-year olds to be equivalent to saving one 30-year old (Johannesson and Johansson, 1996).

In contrast to these studies, our study of older smokers uses a survey methodology that elicits marginal values of life extensions under specified QoL conditions. For moderate levels of disability, our estimates indicate present-value WTP is close to zero, which is generally consistent with Johannesson and Johansson's result. For a general population sample of Canadians, Johnson, et al. (1998) similarly found that WTP for life extensions was positive only for QoL levels that were as good or better than "You can perform usual daily activities, but you have some physical limitations (trouble bending, stooping, or doing vigorous activities), and cannot participate in social or recreational activities because of this health condition." For good QoL levels, however, our estimates for older smokers are in a range that is similar to amortized values of a statistical life. Together, these comparisons confirm the importance of measuring marginal changes in longevity relative to specified health states during the life extension.

Implications

This study elicited stated preferences for quality of life and longevity from a sample of older smokers. Health outcomes were based on gender-specific health benefits of smoking cessation. The experiment separated the loss of smoking benefits from the gain in health benefits by asking subjects to evaluate purchases of hypothetical cigarette filters that would confer health improvements without requiring smoking cessation. Our study indicates that smokers' valuations of life extensions are positive only for the highest quality-of-life level. These estimates help explain differences in previous studies between average value-of-life-year estimates and WTP for one-year life extensions.

Rational smokers continue smoking because the perceived health benefits of cessation are less than the expected value, net of cigarette costs, of continuing to smoke. If smokers believe quitting will yield only low-quality longevity benefits, then it is rational to continue smoking even if smoking benefits are small. If, however, an information program to promote smoking-cessation can offer significant improvements in both the quality and quantity of life extensions, quit rates may improve. There are, of course, other ways of reducing the net benefits of smoking, including raising cigarette taxes, reducing the discomfort of quitting, and restricting locations in which smoking is permitted. Our results imply that the perceived improvement in health outcomes from quitting must be quite high before policies that induce modest reductions in non-health-related net benefits will cause rational older smokers to quit.

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